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Hands On Math: The Construction of a Website to Support the Use of Hands On Activities and Field Trips

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Hands On Math: The Construction of a Website to Support the Use of Hands On Activities and Field Trips

by

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A project submitted to the
Department of Education and Human Development at
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in partial fulfillment of the requirements for the degree of
Master of Science in Education
Abstract

Teachers are facing more and more pressure to make sure that their students perform well on standardized tests. This, in addition to other factors such as having to teach more material in less time, can lead teachers to spend more time engaging in direct teacher-centered instruction and less time on hands-on learning activities. A review of literature shows the importance of using hands-on learning and fieldtrips to help students develop a deeper understanding and generate and sustain students’ interest in the subject.

I have created a website that is meant to provide math educators and parents with ideas for hands-on math activities as well as suggestions for fieldtrip in and around the Rochester area. The website is intended to serve as a resource that will enable math teachers to more easily and effectively implement hands-on learning and fieldtrips into their work with students and expose parents and caregivers to ideas and community resources they might use to create learning opportunities with their children.
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Chapter 1: Introduction

I have found that hands-on learning experiences and fieldtrips can be very effective ways to create and maintain student interest in a mathematics classroom. Getting students interested and feeling enthusiastic about a math topic, can in turn lead to increased motivation to do well and higher achievement (Zahorik, 1996). If part of a mathematical concept can be related to the students' immediate environment, the students have a better chance understanding what's being taught (McNamara & Fowler, 1975). Mathematics instruction that is mainly lecture based is generally not as successful as instruction that includes some amount of manipulative activities and small-group hands-on learning (Honeycutt & Pierce, 2007).

It is my perception that field trips occur with less and less frequently for today's students. Some reasons for this decrease in field trips are: high cost of fuel, lack of funds, the focus on student performance on standardized tests, and pressure from school administration for teachers to show a clear connection to the curriculum (Polochainin, 2008). Overcoming these barriers can be extremely time consuming and challenging; therefore, a big reason teachers do not plan field trips or extensive hands-on learning experiences. I believe that hands-on learning requires a lot of time-consuming planning from the teachers perspective. Many teachers might shy away from this form of learning because of the extensive planning involved.

I believe that the website that I have designed will help teachers in western New York find appropriate hands-on learning activities to implement into their mathematics classroom. In addition, it will help them plan meaningful fieldtrips in the Rochester area.
The fieldtrip ideas, as well as the hands-on learning activities listed on the website are closely connected to the mathematics curriculum. They are accompanied by downloadable worksheets that teachers can use before, during and after the activity. This, I hope, will enable teachers to use less time for planning and encourage them to conduct field trips with their students, as well as implement more hands-on learning activities in the classroom. In addition, some of the fieldtrips listed on my site are very close to home (in the Rochester area) and will help teachers stay within a reasonable budget.

The following chapter will discuss research that supports the use of fieldtrips as well as hands on learning. The teacher’s responsibility to create student interest will be discussed as well, as it is an integral part of learning.
Chapter 2: Literature Review

Hands on learning and field trips can both have a very positive impact on student interest, learning, and achievement. In this literature review I examine the roles these learning activities can have in creating interest in the subject being taught. I discuss the importance of creating student interest, and highlight different aspects of both hands on learning and field trips.

Creating Student Interest

One of the most important responsibilities a teacher has is to get the students interested in the material being taught (Alsina, 2002). As Miller (1987) states a lot of the attitudes toward science and mathematics that are held by students arise from the students' families. These attitudes can range from very positive to very negative. Parents who foster a very positive attitude towards their children's learning of mathematics and science, will likely show that through their selection of toys, subscriptions to math- and science-related magazines, trips to a museum, and talks about topics involving science and mathematics, for example, a dinnertime conversation about how Fibonacci numbers relate to nature.

Mathematics and mathematical concepts can be found everywhere in everyday life. Simple activities such as grocery shopping or sharing a bag of cookies with friends involve math. According to Alsina (2002) we need to also look at social and cultural
characteristics of where we live in deciding on realistic mathematical applications. Some examples of these characteristics include working conditions, retirement plans, and inflation. In this context, Alsina (2002) observed that "all social and cultural realities may have some mathematical interest" (p. 244).

I believe that it is important for educators and parents to know what can be done to make material interesting for students, because it can help improve teaching. Zahorik (1996) notes that it is important for teachers to use the interest of students as a motivating factor as schools are trying to move away from behaviorism and focus more on instruction that is based on constructivist principles. It is important that the students develop sincere interest in the content as a way to construct their own knowledge by "integrating new information into existing personal structures, modifying existing structures, and creating new structures" (p. 553).

Zahorik (1996) recognized that

What teachers do to make things interesting is an important area of investigation, because understanding what teachers do is a first step toward improvement of teaching, and using interest as a motivator rather than other means of motivation is especially important as teachers attempt to move away from behaviorism toward instruction based on constructivist principles. (p. 553)
Zahorik (1996) also recognizes that teachers often use extrinsic motivators like material prizes, grades, praise, and privileges to get students to engage, but another very important way of motivating students is to get them interested in the topic. He notes that nearly every teacher in his study saw hands-on activities as a very important strategy to generating and maintaining student interest. The physical involvement of hands-on activities can create student interest. Other ways to establish student interest, mentioned by Zahorik (1996) are: a) using personalized content, b) creating student trust by respecting the students’ intelligence, their integrity and pride. This can be done by giving students opportunities to "show off" their knowledge, c) engaging in group tasks, d) using a variety of materials, such as pattern blocks in mathematics, e) demonstrating teacher enthusiasm, f) doing practical tasks, g) using a variety of activities. On the other hand, Zahorik suggests that teachers avoid sedentary activities, unsuitable tasks, artificial tasks, and student distrust when trying to create interest.

Semper (1990) noted that intrinsic factors, such as curiosity, enjoyment of learning, and mastery of challenge, are very potent motivational tools for student engagement. Students can become engaged in an activity simply because the activity itself is intrinsically interesting to them (Zahorik, 1996).
Hands-On Mathematics Learning

For the purpose of this project I draw on the Zahorik (1996) to define the term hands-on activities. In his words:

Hands-on activities refer to a range of activities in which the student is an active participant rather than a passive listener. The term includes the use of manipulatives such as pattern blocks in mathematics; playing games of all kinds; participating in simulations, role playing, and drama; engaging in projects such as growing seedlings in science or making television commercials in Spanish; and solving problems or puzzles such as determining the sugar content of chewing gum. (p. 555)

Adeeb, Bosnick, and Terrell (1999) believe that all children can learn mathematics and should be given an opportunity to do so. They also believe that problem solving, hands-on activities, interactive learning experiences, and alternative assessment should play a bigger role in facilitating mathematics to meet the needs of an "ever-changing student population" (p. 27). An example of a hands-on activity could be to have students race wooden toy cars and calculate their average speed.

Different students benefit from different teaching approaches. One student might learn best while sitting at his desk in the classroom listening to the teacher; whereas another student gets fidgety very easily, and for this student teaching approaches such as field trips and hands-on activities are very important (Polochanin, 2008). These hands-on activities don’t necessarily have to happen outside of the school setting. They can also
very well happen while sitting at a desk inside of a classroom. One example would be to have students manipulate cut-out cardboard triangles and squares during an introduction to the Pythagorean Theory. During this activity students get to experience firsthand how the Pythagorean Theorem works. Students arrange three squares along the sides of a right triangle and will be able to visualize that the surface area of the biggest square is equal to the sum of the two smaller squares. This can help students understand what the formula is referring to and it lets them visualize it, therefore making it easier to understand for some students.

Freeman, McPhail, and Berndt (2002) examined what sixth graders described as activities that do and do not help them learn throughout their classes. Students were asked to classify options as either a situation of interest or a situation of noninterest. Their study involved 47 middle school students from a rural mid-western school in the United States. What was most often identified by the students to facilitate their learning were hands-on activities such as building models and conducting experiments. Twelve students chose doing an experiment as a "situation of interest," but none of the students chose it of a "situation of noninterest" (p. 340).

Three teacher educators, Adeeb, Bosnick and Terrell (1999), hoped to help teachers in urban elementary school settings meet the needs of an always-changing student population. For the researchers, it was very important for every child to feel successful and accepted, and recognize that mathematics is not only relevant inside the classroom, but also outside the classroom. The teachers used handmade, wooden
manipulatives to teach students from urban elementary classrooms basic math concepts such as addition, subtraction, fractions, and percentages. Specifically, the teachers used hand-size wooden basketball goals and race cars to teach the students about fractions and metric measurements. This was done in a hands-on, cooperative learning environment in which students were invited to use math in a fun and meaningful way. The math lessons enabled the students to learn through play how math is used in the real world. For example, students took part in simulation activities involving the process of buying merchandise in a store, restaurant and entertainment facility, as well as tracking a savings account, planning a vacation and performing the tasks of a bank teller, a waiter, or cashier. Unfortunately, Adeeb, Bosnick and Terrell do not include details about the demographics and the number of students who participated in the study. They did mention that the students were from urban elementary classrooms.

Adeeb, Bosnick and Terrell (1999) concluded that "the classroom milieu teachers create can encourage or discourage a child to ask questions or share answers, thereby building or destroying a child's confidence in their mathematical abilities" (p. 32).

Alsina (2002) recommended that changes be made in mathematics education because of the increasing need of everybody being expected to have a certain knowledge of mathematics. Alsina believes that it is important to teach math in local and global contexts that relate to the realities of today's world. Mathematics teaching should be as often as possible related to the real world. For example, students could use mathematical concepts to find out what it costs to own a motorcycle or the teacher could set up a
geometry lesson using geometrical characteristics and measurement of the school's buildings that could have been explored beforehand during a hands-on geometry session.

Alsina believes that teachers should take the local and global issues into account when choosing applications. Considering questions related to time such as: In what decade or century are we teaching and living? What is happening in today's news? What are the immediate events that might related to my students? and the location of the school: Are we in a big city or a small village? Are we in a developed country? Are there factories that could be visited?

According to Alsina, an important aspect for teachers to consider when designing applications is that they need to be realistic regarding the time in which they are living. For example, Alsina mentions that problems with triangles related to land measurement using topographical instruments are useful, whereas problems related to measurements with knots and shadows are useless.

Investigating the steps of stairs (depth, height and inclination of steps) is one example of a hands-on activity that Alsina (2002) mentions. This experience has a very universal value, since all people need stairs that are easy to climb and almost all people wear shoes. Alsina suggests that students measure the height, the depth and the inclination of steps. Then they can determine the upper and lower bounds of these measurements, as well as investigate when it would become more convenient to have a ramp versus a stair.
While teaching probability concepts to college students, Honeycutt and Pierce (2007) found instruction that was mainly lecture-based was not very successful because students were not interested in the material and did not understand and remember many of the important concepts. The researchers then developed a laboratory exercise in probability, which was based on manipulative activities and small group learning and found that roughly 70 percent of their students agreed that this laboratory exercise helped them understand “concepts taught in the lecture portion of the course” (p. 544).

Ferguson and Hegarty (1995) conducted a study to find out how learning about mechanical systems was affected by using different media. Twenty-four undergraduates (18 women, 6 men) at the University of California participated in the study. Their participation partially fulfilled an introductory psychology course requirement. The students did not have prior formal physics instruction.

During this experiment, some students learned a concept by using real pulley systems, while other students learned the same concept by using only simple line diagrams. The researchers investigated three learning outcomes: a) the ability to compare pulley systems' efficiency, b) the ability to understand mechanical systems, and c) the ability to apply knowledge to real-world mechanics problems. The research findings showed that the students working with real pulley systems and students working with the diagrams both made equal improvement on the task to be learned. An increased understanding of the concept was also shown by all students. On the other hand, the students who worked with the real pulley systems solved application problems more
accurately than those students who used the diagrams. The researchers found that the opportunity to manipulate real systems contributed to better student performance on application problems.

**Fieldtrips**

Polochanin (2008) states that "field trips broaden students' lives, provide them with valuable cultural experiences, and – who knows – perhaps give them a store of background knowledge for their next bubble-in test" (p. 25).

According to Ramey-Gassert (1997), science learning that occurs in environments such as museums, science centers, and zoos can provide students with captivating experiences that can be related closely to the curriculum. Informal science learning environments such as those found in a museum are also motivational, engaging, enjoyable, and nontargeting. In a museum, students have opportunities to interact with real-world objects, such as investigating the Golden Ratio and the Fibonacci Numbers in a Mathematics Museum. They won't have to learn the often new or confusing terminology associated with a certain topic as would be common in a classroom setting, which may depend more on verbal or written symbols for communication (Ramey-Gassert, 1997).

Ramey-Gassert, Walberg, and Walberg (1994 as cited in Ramey-Gassert, 1997) state that "museum learning has many potential advantages: nurturing curiosity,
improving motivation and attitudes, engaging the audience through participation and social interaction, and enrichment. By nurturing curiosity, the desire to learn can be enhanced" (p. 434).

Resnick (1987 as cited in Ramey-Gassert, 1997) elaborated on the differences between in-school learning and out-of-school learning. He came to the conclusion that in-school learning is usually based in symbols and the abstract, therefore it's solitary learning and has little to no connection with the actual objects or events that are represented. On the other hand, Resnick stated that "out-of-school learning commonly involves the accomplishment of an intellectual or physical task by a group that is interacting using real elements, which allows learning to take on greater meaning" (p.434). One example for out-of-school learning would be to launch a model rocket and determine its' height. Students could be working in teams and within their team decide on a useful approach to find the height of the rocket. They would then implement this approach and later on compare it with the approaches taken by other teams of their class.

Ramey-Gassert (1997) states in conjunction with informal science education, that virtually all experiences where a child interacts with the natural world, for example science investigations on the playground (the incline of a slide, the height of a climbing structure) or a trip to the produce section of the grocery store (variety of fruits and vegetables), generate science learning in some sense. This can also very well be applied to mathematics learning. For example comparing prices of produce in the grocery store.
Other concepts than can be explored are those of markup and markdown, sales, clearance, and the cost effectiveness of self check-out lines.

McNamara and Fowler (1975) investigated the different effects of outdoor learning using available natural resources, and the effects of indoor learning using pre-packaged materials. They concluded that:

(a) concepts that are an integral part of the students' environment are best learned in the out-of-door environment; (b) if parts of the concept can be related to the students' immediate environment, the concept has a better chance of being understood, whether the concept is concrete or abstract; (c) critical thinking is enhanced in the out-of-door environment. This is especially true for the average to below average student; (d) investigating in the out-of-door environment increases the student's desire for that environment; (e) the student that is more academically challenged tends to prefer the environment in which he is exposed. (p.417)

It is important that the purpose of a field trip is broad, meaning to cover more than just one basic mathematical concept during one trip. According to Keown (1984), the events of the fieldtrip should have maximum carryover back in the classroom in relation to the curriculum. Good timing of a field trip is very critical. Keown suggest that teachers introduce concepts, as well as make use of models, films, and pictures prior to the field trip since that can be easily implemented within "the confined nature of the classroom" (p. 44).
Alsina (2002) states that taking a look at the area in which the school is located will likely give an educator ample opportunities for fieldtrips, such as visiting factories, visiting notable buildings and making measurements, looking at the way public transportation is organized, investigating the way pollution is measured, and many other interesting places as ways to generate mathematical activities.

The next chapter will discuss the project design and application. I will talk about how the website was built and also highlight some of the content of the site.
Chapter 3: Project Application and Design

The website I designed is meant to be a resource to help teachers and parents find meaningful and educational ways to explore mathematical concepts hands-on inside and outside of the classroom. I anticipate that the activities and field trip ideas listed on the site will create interest and get students excited about learning mathematics. Some of the field trip ideas listed are Rochester specific and highlight some great educational venues the Rochester, New York area has to offer. Teachers as well as homeschooling parents can use the website to find meaningful ways to create student interest, excitement and a willingness to learn.

The website has three main sections: a list of all the field trip ideas, a list of hands-on activities ideas and a rationale regarding the importance of field trips and hands-on learning. A link to the literature review and references is included.

Most of the field trip ideas have a page that lists the following information:

- A brief description of the venue
- Physical address and contact information such as phone number and website
- A map showing the location of the venue
- Mathematical activities and/or inquiry questions that can be completed at the location

The hands-on activities listed have a page with more information on the activity as well as links to other websites with more information on the topic.
It is my goal to provide a resource of ideas and materials that educators and parents can use to create interest in learning and exploring different mathematical concepts.

**Significance of Project**

Mathematics is a discipline that can be found everywhere. Mathematics is found in nature (e.g., Fibonacci numbers), in the workplace, in construction and architecture, and in the home just to name a few. Most students don't think of mathematics as a very exciting subject in school neither do they think that it's fun to learn. The author strives for teachers to explore the website and offer students a more varied approach to learning and exploring mathematics, by introducing students to the math all around them in the real world and to foster excitement and curiosity about its many applications.
General Website Information

I used Google Sites to build the site. Google sites is free to use and has a lot of features that can be included on the website. "HandsOnMath Trips" incorporates pictures, maps, and links to other websites of interest. The URL is https://sites.google.com/site/handsonmathtrips/home.

In addition to the "Welcome!" page, the website has three main sections: "Field Trip Ideas," "Hands-on Math in the Classroom," and "Why fieldtrips and hands-on math?" On the bottom of each page is a comment box where visitors to the site can leave suggestions and comments.

The "Welcome!" Page

The "Welcome!" page is the main page of the website (see Figure 3.1). From here visitors can access all other pages. This page also includes the purpose and a brief description of the site.

The "Field Trip Ideas" Page

The "Field Trip Ideas" page has three sections. One section shows a map of Rochester specific locations and venues (see Figure 3.2) and a listing of these fieldtrip ideas (see Figure 3.3). Many of the ideas listed are links that will take the visitor to a page designed for that specific idea. The second section lists field trip ideas that are not Rochester specific and can be done in lots of different locations (see Figure 3.4). The
third section of this page has a listing of external links that might be of interest for
teachers and parents that are looking for fieldtrip ideas.

Figure 3.1 - Screenshot of the "Welcome!" page.

![HandsOnMathTrips]

**Welcome!**

This website is meant to provide you with wonderful ideas of hands-on math activities in addition to field trip suggestions in and around the Rochester area as well as ideas that are not Rochester specific.

If you are an educator, this site will give you suggestions of activities to do outside of the classroom. The students will be enlightened to be able to use the math that they are learning in the classroom out in the world.

If you are a parent, this site will help you find meaningful activities to do with your kids that are both fun and highly educational.

Feel free to leave comments and suggestions!

Figure 3.2 – Screenshot of the map on the "Field Trip Ideas" page

![Map of Rochester area with field trip locations]
Greater Rochester Area Trip Ideas:

- High Falls
- Seneca Park Zoo
- RMSC - Rochester Museum and Science Center
- The Strong - Museum of Play
- Imagine RIT
- Hawk Banding Station at Braddock Bay (Owl Woods)
- Seabreeze Amusement Park
- Salmon Creek
- Rochester Architecture
- American Rock Salt
- Niagara Falls
- Renewable/Green Energy in our region

Not Rochester specific Trip Ideas:

- Farm Visit
- Factory Visit
- Exploring Mathematical Patterns in Nature
- Rocket Math (Let's launch a model rocket)
- Bowling Fun
- Math in Sports
- Mathematics Field Day
- Bus/Garbage Truck Routes
- Math in the workplace
- Grocery Store visit (let's explore coupons and sales)
- Bank Visit
- Real Estate
- The Museum of Mathematics in NYC
Some of the pages designated to specific venues or experiences show pictures see Figure 3.5), contact information of the venue, a map of the location, and ideas for implementation of the activity (see Figure 3.6).

**Figure 3.5 – Screenshot of pictures from the Rochester Museum and Science Center**
Bowling Fun

Taking your students or family out for a game of bowling can be a fun, and with a little bit of planning, educational, experience.

Ask the person working at the bowling alley if they can turn off the screens that show the scores of the people of your group playing. Now you and your students can see bowling as an educational experience by having everyone keep track of their own scores and later on comparing these scores to the scores kept by the computer. Students can then calculate their average score, the teams’ average scores, the statistics of the games, etc.

Open the link below for a document outlining the basics of keeping score.

A great bowling alley in Rochester:

DOMM'S Bowling Center

Contact Information:

Address:
640 Ridge Road West,
Rochester, NY 14615

Phone:
(585) 885-8472

E-mail:
Dommsbow@yahoo.com

Website:
www.dommsbowling.com

Bowling _ keeping score.doc (203k)
The "Hands-On Math Ideas" Page

The "Hands-On Math Ideas" page lists math activities that are hands-on and can be done within the classroom (see Figure 3.7). Each idea is a link that will lead the visitor to another page that is specifically created for that activity (see Figure 3.8). This page has links to external sites of interest or attached lessons/worksheets.

Figure 3.7 – Screenshot of the "Hands-On Math Ideas" page

Figure 3.8 – Screenshot of the subpage for "The Pythagorean Theorem"
The "Why field trips and hands-on math?" Page

The "Why field trips and hands-on math?" page provides the visitor with explanations of why field trips and hands-on math activities can be a great addition to their regular classroom curriculum and instruction (see Figure 3.9). This page also hosts a link to my literature review and references.

Figure 3.9 – Screenshot of the "Why field trips and hands-on math?" page
Chapter 4: Conclusions and Future of Website

Conclusions

I have designed this website to be a resource for parents and teachers, giving them ideas and suggestions for real world, hands-on math experiences. Oftentimes as a math teacher, I find myself in situations where I am just drawing a blank while trying to think about a creative and interest invoking way to teach a certain mathematical concept. I am always looking for a resource that will give me ideas. My hope is that parents and teachers will use the website as a resource.

The site lists venues in the Rochester area as well as more general locations that can be visited by school classes and families and have the potential to be a great educational experience. In addition, some of the hands-on math activities have links to interesting external websites as well as links to lesson plans and worksheets. Visitors to the site can leave comments and suggestions and my hope is that the comment section will be used to share other great ideas.

Ideas for the Future of the Website

This website is a work in progress that can be added to at any time. I am planning to explore further venues in and around Rochester and add these to the site in addition to adding more lesson plans and worksheets. I expect this part to be complete by the end of 2013. I plan to the comments posted in the comment section of the site to gather more
ideas and also use any feedback to develop the page more fully. I am investigating the idea of expanding the site into a sharing platform as a way to broaden the accessibility for a wider range of teachers and parents. Doing so will enable a continued sharing and exchanging of ideas about hands-on math teaching and field trips that are suited for math students. The sky is the limit.
References


